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Indian Standard

METHODS OF TEST FOR VITREOUS ENAMELWARE

PART 2 TEST METHODS

Section 4 Resistance to Thermal Shock

(First Revision)

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Gr 1

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Indian Standard

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0. FOREWORD

0.1 This Indian Standard (Part 2/Sec 4) (First Revision) was adopted by the Bureau of Indian Standards on 15 July 1988, after the draft finalized by the Ceramicware Sectional Committee had been approved by the Chemical Division Council.

0.2 The Committee, while reviewing IS:3972-1968* decided to publish this standard in two parts. Part 1 will deal with production of specimens for testing in two sections, namely, Sec 1 Enamelled sheet steel and Sec 2 Enamelled cast iron. Part 2 would deal with various test methods applicable to vitreous enamelled cast iron. The Committee also decided that Part 2 will have various sections and each section would deal with a particular test method. Section 1 and Section 2 covering resistance to citric acid at room temperature and boiling temperature; and low and high voltage test for detecting and locating defects have already been published while Sec 3, Sec 5 and Sec 6 covering resistance to boiling water and water vapour; resistance to hot alkali (sodium hydroxide); and reflectance and specular gloss, respectively are under print.

0.3 In this part (Part 2/Sec 4) of the standard, the method for determination of resistance to thermal shock has been prescribed and the same has been aligned with ISO 2747-1973 'Vitreous and porcelain enamels — Enamelled cooking utensils — Determination of resistance to thermal shock', issued by the International Organization for Standardization (ISO).

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS:2-1960†.

*Methods of test for vitreous enamelware.

†Rules for rounding off numerical value (*revised*).

1. SCOPE

1.1 This standard (Part 2/Sec 4) specifies a method for determining by successive thermal shock tests, the behaviour of vitreous enamel cooking utensils and similar articles under sudden changes of temperature.

NOTE — A finished enamel coating is generally under a desired compressive stress. The stress is more or less altered under conditions of use; for example, cooking utensils are heated and cooled in such a way that the enamel may be subjected to tensile stress to which it is sensitive. This danger to a given enamelled article increases with the difference in temperature during thermal shock. It is for this reason that the test for thermal shock resistance is carried out with increasing thermal shock temperature.

2. TERMINOLOGY

2.1 For the purpose of this standard, the following definitions shall apply.

2.1.1 *Thermal Shock Test* — The series of operations commencing with the pouring of cold water into the heated test specimen and ending when the thermal shock temperature for the subsequent thermal shock test has been reached.

2.1.2 *Thermal Shock Temperature* — The temperature to which the specimen is heated before being chilled with cold water.

2.1.3 *Thermal Shock Resistance* — The difference between thermal shock temperature and water temperature at which the specimen shows the first damage on chilling or during subsequent heating.

2.1.4 *Damage* — Any chipping or tension cracks in the enamel visible at a distance of 25 cm by normal sight.

3. SAMPLING

3.1 The sample shall be representative of the entire consignment. The scale of sampling shall be agreed upon between the purchaser and the supplier.

3.2 At least three samples shall be tested.

3.3 The utensils to be tested shall serve as the sample without any modification.

4. TEST FOR RESISTANCE TO THERMAL SHOCK

4.0 Principle — The test for thermal shock resistance consists of a series of single thermal shock tests with a temperature increase of 20°C between each thermal shock. The specimen is heated from outside and then chilled inside with water at 27 ± 2°C. The thermal shock temperature applied for the first test is 200°C. The test ends when the first visible damage occurs.

4.1 Apparatus

4.1.1 *Electric Hot-Plate* — The diameter and maximum output of the electric hot-plate shall be as given in Table 1 in accordance with the internal diameter of the sample.

TABLE 1 DIAMETER AND MAXIMUM OUTPUT OF THE ELECTRIC HOT-PLATE

Internal Diameter of Sample mm	Hot Plate	
	Diameter mm	Maximum Output W
(1)	(2)	(3)
Up to 180	145	1 000 ± 100
Over 180 but up to 220	180	1 500 ± 150
Over 220	220	2 000 ± 200

4.1.1.1 For testing specimens with an uneven base, the hot-plate must be surmounted by a ring filled with copper grit of grain size 0·100 to 0·125 mm.

4.1.2 *Temperature Measuring Device*—To measure the temperature of the specimen accurate to ± 2°C.

4.1.3 *Thermometer* — Range 0-110°C.

4.1.4 *Water Receptacle*

4.1.5 *Stop-Watch*

4.2 Procedure — Provide sufficient water at a temperature of 27 ± 2°C for each thermal shock test so that the specimen can be filled to a depth of 30 mm, if possible. More water at this temperature shall be available. Heat the specimen by means of preheated electric hot-plate, operated at its maximum output. The temperature shall be measured inside at the base of the specimen at a distance of a quarter of the internal diameter from the side of the utensil.

4.2.1 *First Thermal Shock Test*

4.2.1.1 When the temperature of 200 ± 5°C (thermal shock temperature) has been reached, after 5 ± 1 second, remove the specimen from the hot-plate, fill it with one pouring to at least 30 mm of depth with water at 27 ± 2°C and for rapid cooling, place it in water also at 27 ± 2°C. When the specimen reaches the room temperature, pour out the water, dry the specimen with an absorbent paper and examine it for damage.

4.2.1.2 If there is no damage, heat the specimen to 220 ± 5°C (thermal shock temperature of the second thermal shock test). If damage occurs during heating before the test is completed, take the temperature of 200°C as the thermal shock temperature. For testing further specimens, choose a temperature lower than 200°C for the first test and state this in the test report.

4.2.2 *Second and Further Tests*— If the specimen comes through the first test undamaged, repeat the test at a temperature of 220 ± 5°C. Carry out the second test as described in **4.2.1.1.** The temperature shall be now 240 ± 5°C when heating up according to **4.2.1.2.** If any damage occurs before the test is completed, the thermal shock temperature is then taken as 220°C. If no damage occurs, carry out further tests as described with a temperature increase of 20°C between successive tests until damage occurs.

4.3 Expression of Results

4.3.1 *Average Thermal Shock Temperature* — Calculate the arithmetic average from the thermal shock temperatures of the individual specimen at which the first damage is observed. If one of the individual values of three tests differs by more than 50°C from the average thermal shock temperature, two further tests shall be run. The arithmetic average is then taken from the five values.

4.4 Test Report

4.4.1 The test report shall include the following particulars:

a) Description of specimen (shape, internal diameter, thickness of enamel, volume, mass);

b) Method of sampling;

c) Number of specimens tested;

d) Diameter and maximum output of hot-plate and use, if any, of a surrounding ring;

e) Thermal shock temperature at which the enamel first showed damage, individual and average value;

f) Average thermal shock resistance;

g) Kind of damage to the enamel; and

h) Amount of water used for thermal shock if it was not possible to fill the specimen to a depth of 30 mm.

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